Digital Arts and Humanities Workshop Series – Fall 2017

Fridays @ noon -- Scholars Commons IQ-Wall

	Date	Topic	Presenter
	Aug. 25	Intro to Visualization	Michael Boyles
	Sep. 1	Intro to Digital Humanities	Tassie Gniady
	Sep. 8	Virtual Reality	Bill Sherman
	Sep. 15	Intro to R	Tassie Gniady
	Sep. 22	Advanced Media	Chris Eller
	Sep. 29	Augmented Reality	Chauncey Frend
	Oct. 13	R for Text	Tassie Gniady
	Oct. 20	Network Graphs	David Kloster
	Oct. 27	IQ-Tables & Touch-Enabled Software Workflows	David Reagan
*	Nov. 3	3D Scanning & Printing	Jeff Rogers
	Nov. 10	3D Photogrammetry	Tassie Gniady
	Dec. 1	R for Twitter	Tassie Gniady

3D Scanning
within the UITS Advanced Visualization Lab

(for the digital arts & humanities at Indiana University)

Jeff Rogers and Tyler Jackson
Principal Project Analyst, Advanced Visualization Lab
Indiana University

November 3, 2017

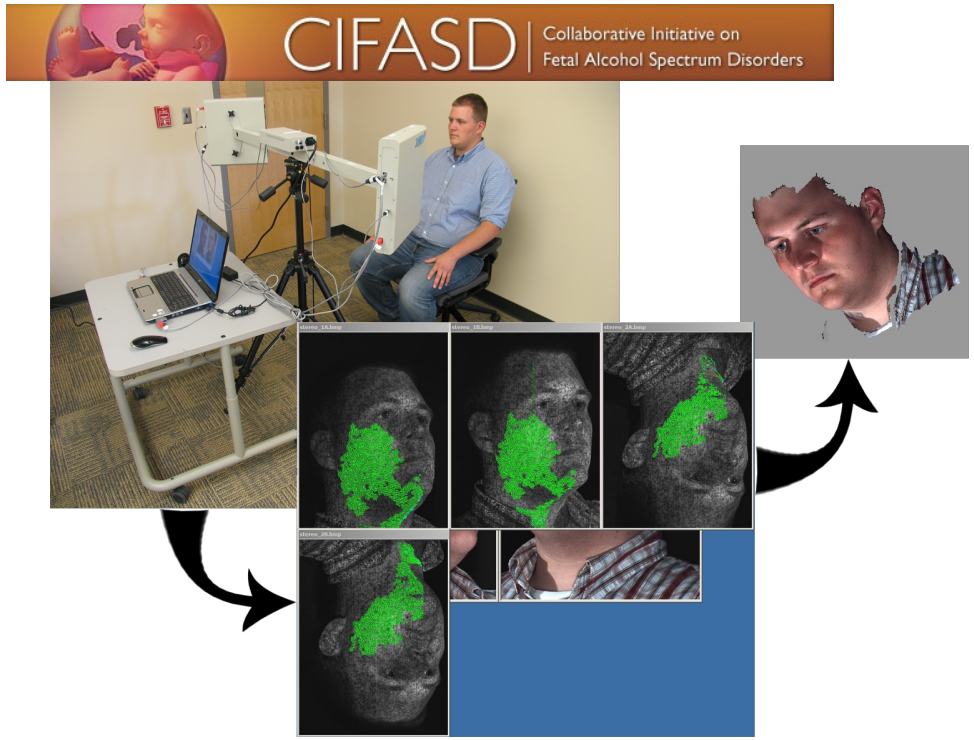
Goals for Today

Goals

- Example projects
- Why digitize?
- 3D digitization technologies are available
  - 3D Software modeling
  - Software-based photogrammetry (11-10-2017)
  - Hardware-based volumetric
  - Hardware-based 3D surface scanning (Today's tech focus)
- Hardware-based 3D surface scanning
- Post-processing workflows for all digitization technologies
- Recommended scanning and printing resources

3D Digitization
Example Projects

- Medical Related
  - CIFASD Imaging with Tatiana Foroud, Ph.D.
  - Travis Bellicchi Prosthodontics Fabrication

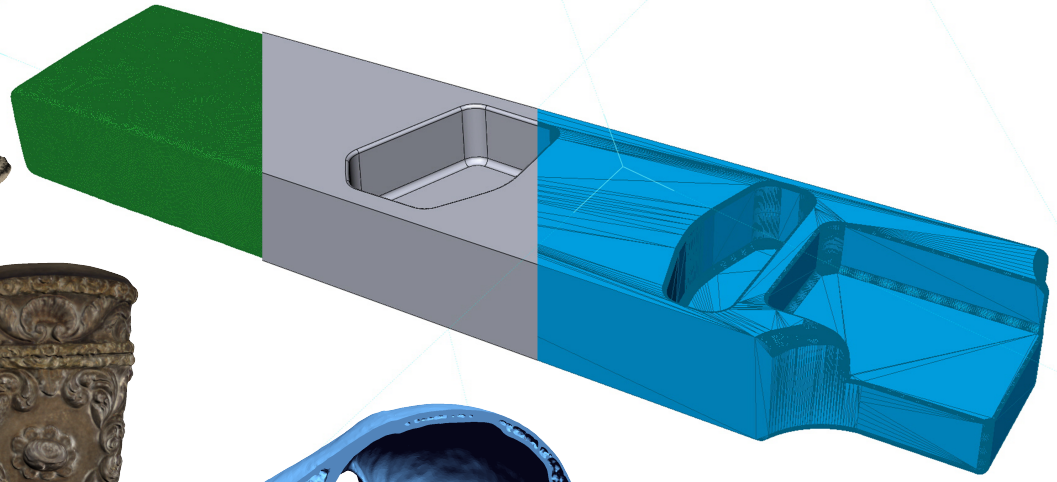


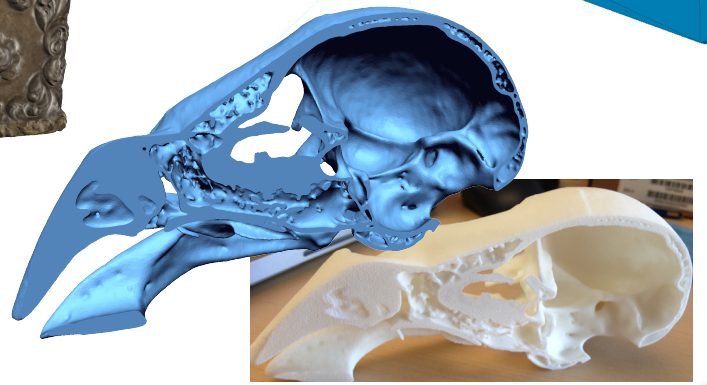
3D Digitization
Example Projects

- Cultural Heritage
  - Benjamin Harrison Presidential Site
  - Ruth Lilly Medical Libraries
  - Dr. Leo J McCarthy Collection
  - Old Oaken Bucket

Why Digitize?

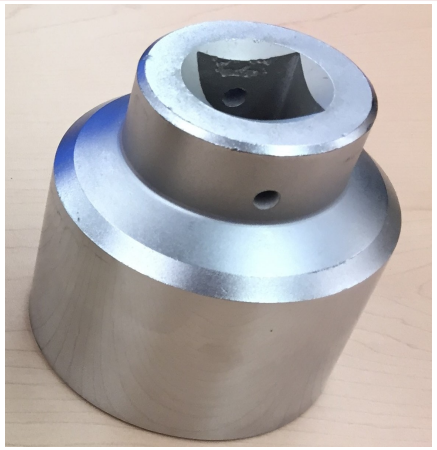
- Digital preservation
- Artifact/Part analysis
- Metrology for reverse engineering, part inspection, redesign, and manufacture
- Reproduction through 3D printing





3D Digitization vs. 3D Modeling

3D Digitization	3D Modeling
Pros	Pros
• Faster for complex or organic shapes • Captures materials	• Faster for simple shapes • Parameterization inherent to modeling
Cons	Cons
• Some materials don't digitize well • Parameterization can be cumbersome	• Time consuming modeling on complex shapes • Manual material creation

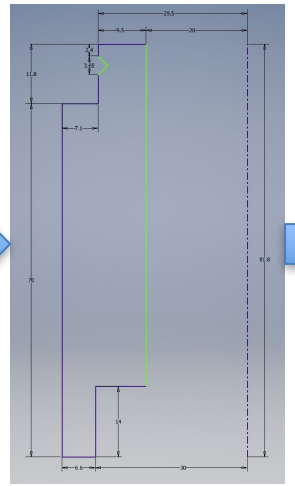


3D Modeling Options

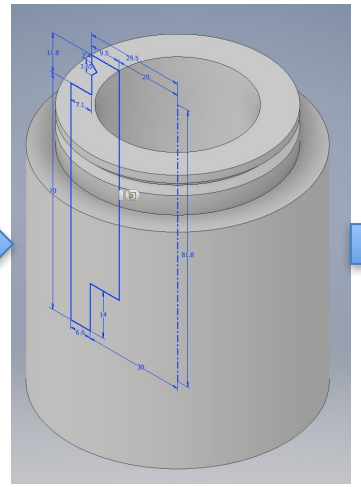
Measure and Model with Software Tools

- Lots of Software options
  - Polygonal Modeling: Maya, Max, Zbrush, Blender, …
  - Parametric Modeling: Inventor, Solidworks, Rhino3D, …
- Requires skills with select modeling packages
- Example Project: Scope Lens Extension

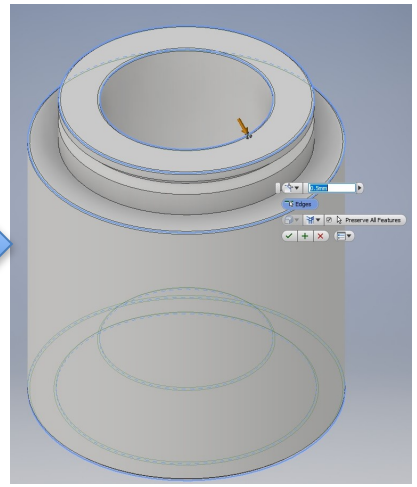
Measure



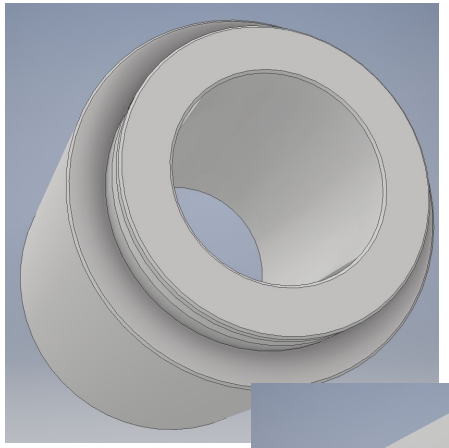
Profile Sketch

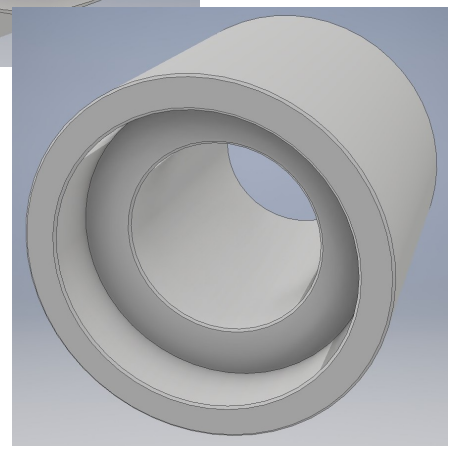


Revolve



Chamfer





3D Digitization Options

Hardware-Based Surface Scanning

- Structured light scanners
- Laser time-of-flight scanners
- LIDAR systems

Leica LIDAR (> $50K)

Matterport ($4K)

NextEngine ($3K)

Minolta ($30K - Retired)

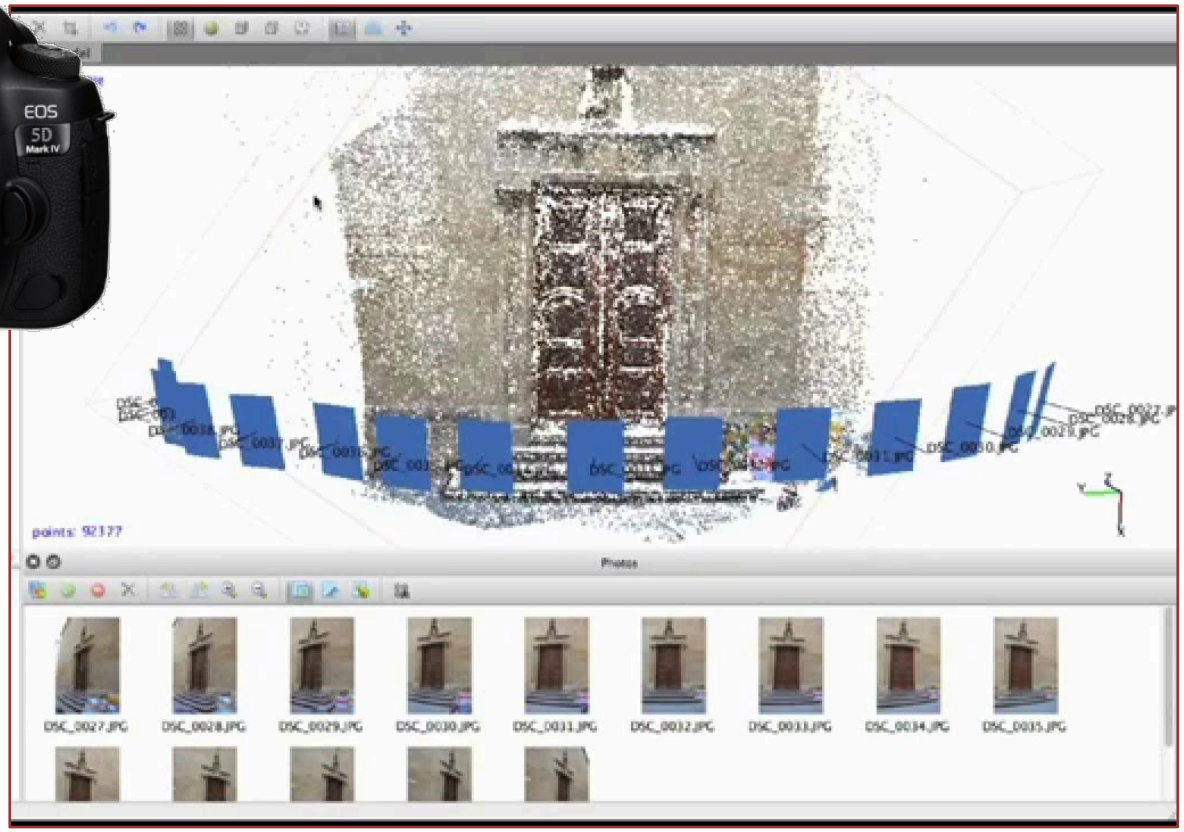
GoScan ($25K)

3DMD ($45K)

3D Digitization Options

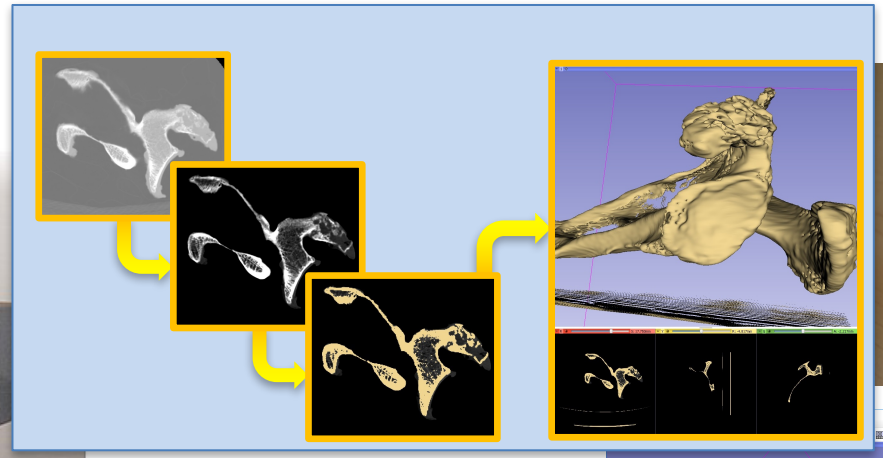
Photogrammetry Surface (Friday, Nov 10th, 2017)

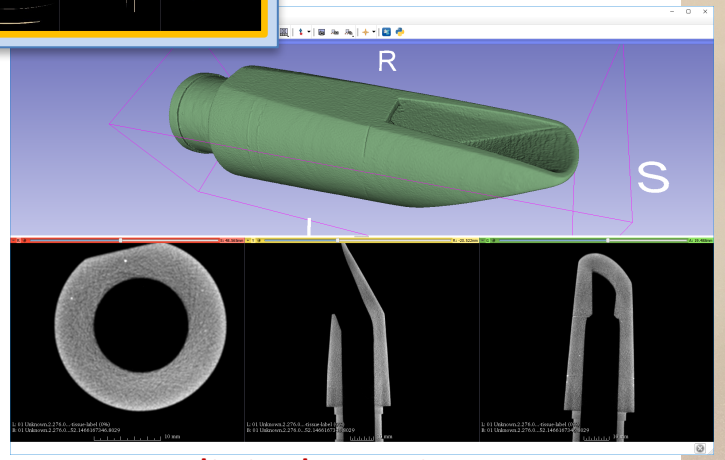
- Capture 2D Images
- Structure from motion techniques

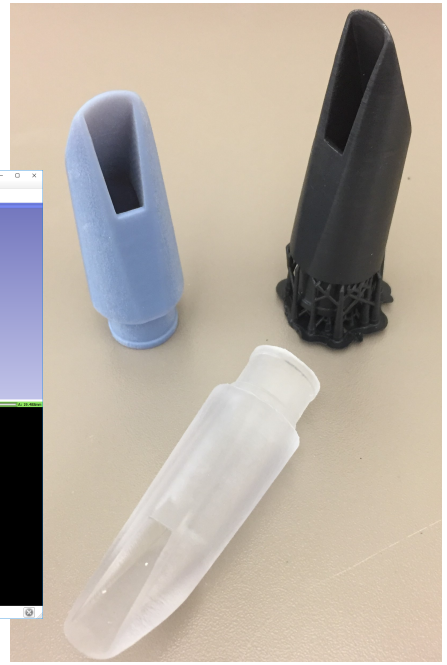


3D Digitization Options
Hardware-Based Volumetric

- CT/ MicroCT/CBCT
- MRI







Data Capture: Indiana Institute for Biomedical Imaging Sciences - Preclinical Imaging

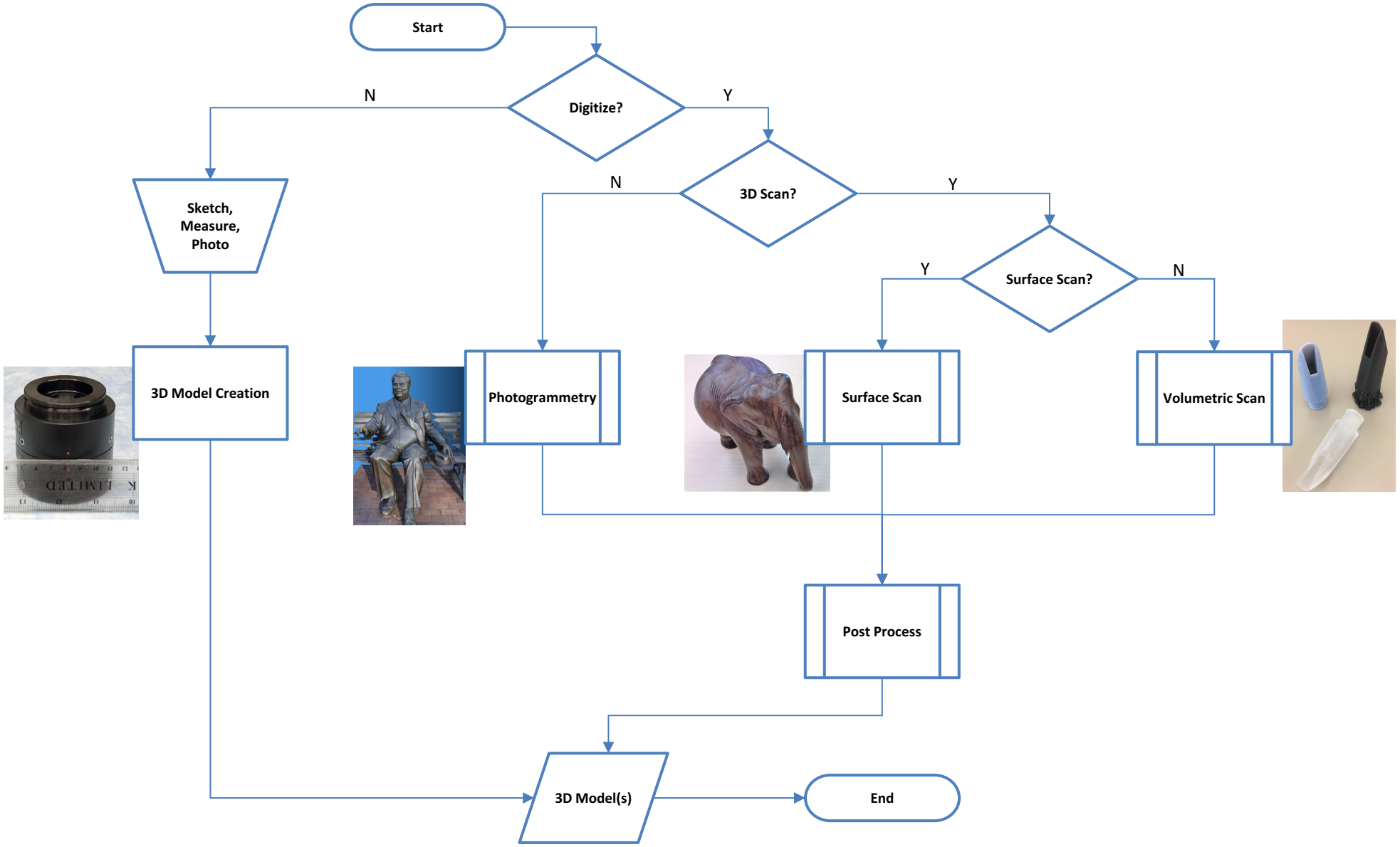
Post Processing Workflows: Tested AVL Workflows in Place

3D Digitization Options

Surface Scanning	Photogrammetry	Volumetric Scanning
Pros	Pros	Pros
• Greater spatial accuracy (<1mm) • Less time on site • Real-time feedback on quality • Less post-processing time • Less chance of user error/failed scan	• Affordable equipment • Highly portable • Underwater and aerial (drone) compatible • Potential to reprocess for greater accuracy • Potential for better color capture • Potential for more detail capture	• Captures internal structures • Very high resolution (~9um)
Cons	Cons	Cons
• Expensive equipment • Must upgrade equipment to achieve future gains	• Lower spatial accuracy • Lengthy, computationally expensive post-processing • Challenges of processing in the field (laptop) • Potential inadequacy/failure of photo set • More time on site	• Costly scan • Cumbersome Isosurfacing • Some materials cause noise • Size limitations • Object must be brought to scanner

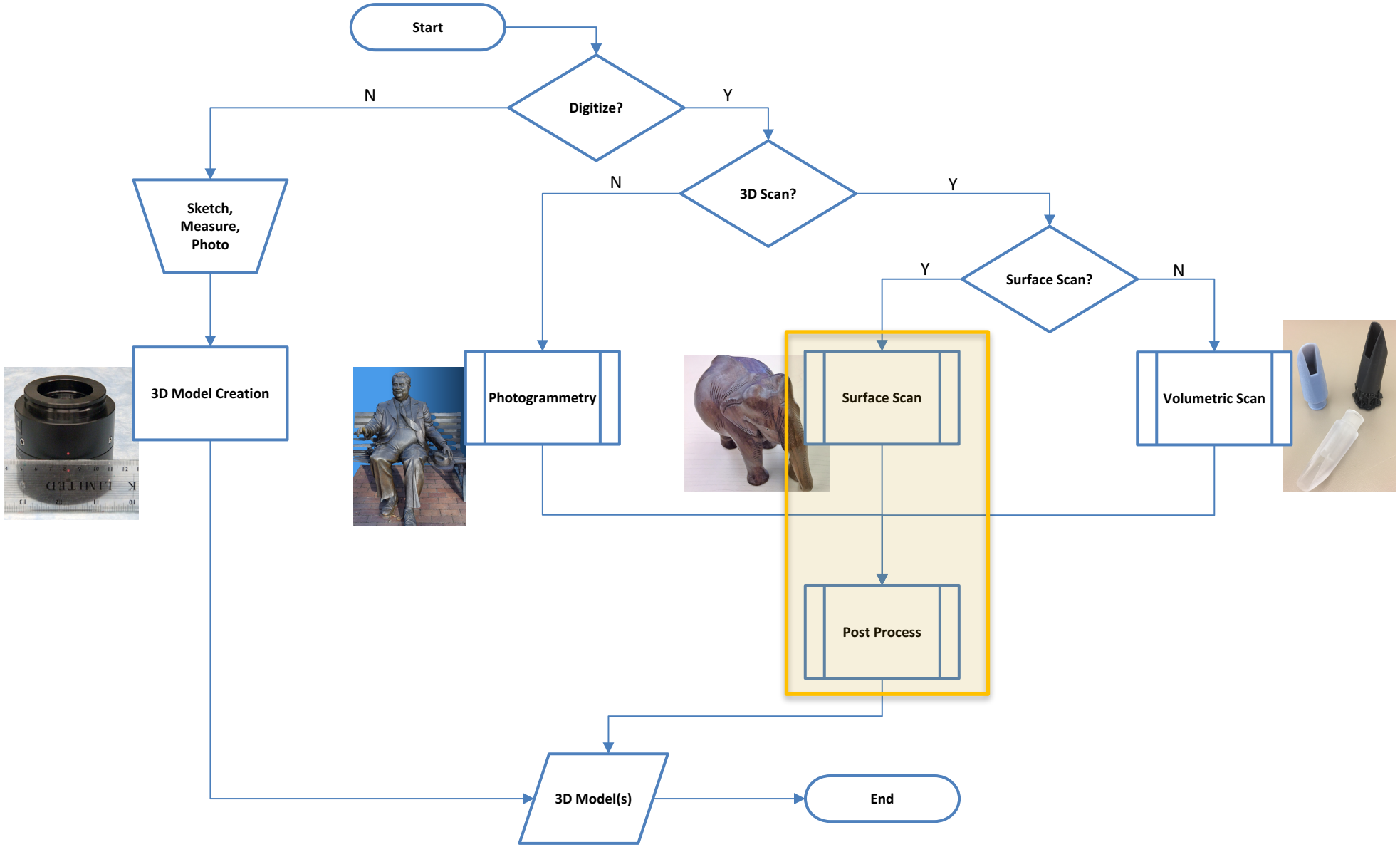
3D Digitization Options

The Decisions



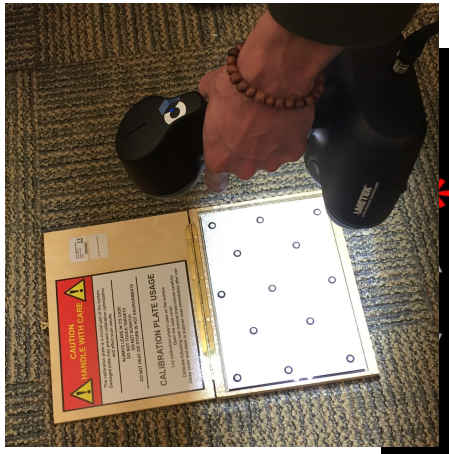
3D Digitization Options

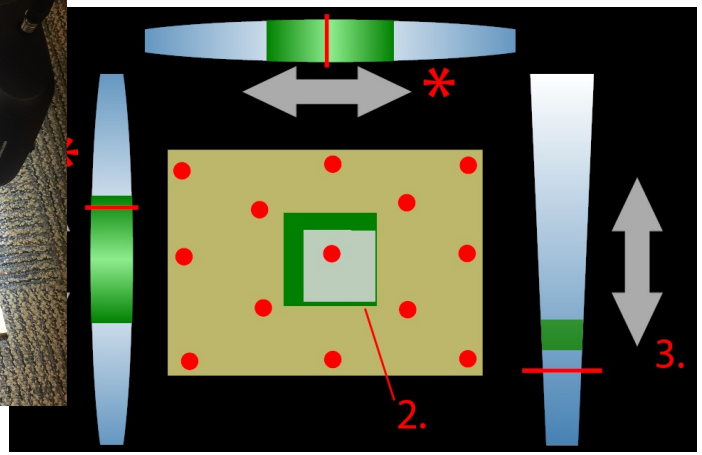
The Decisions



Hardware-Based 3D Scanning
Setup

- Scanner Preparation
  - Calibration
  - Options
    - Color
    - Resolution
    - 3D mesh options
- Object Preparation
  - Surface preparation
    - Markers when needed
    - Dusting when needed
  - Foresee scan angles

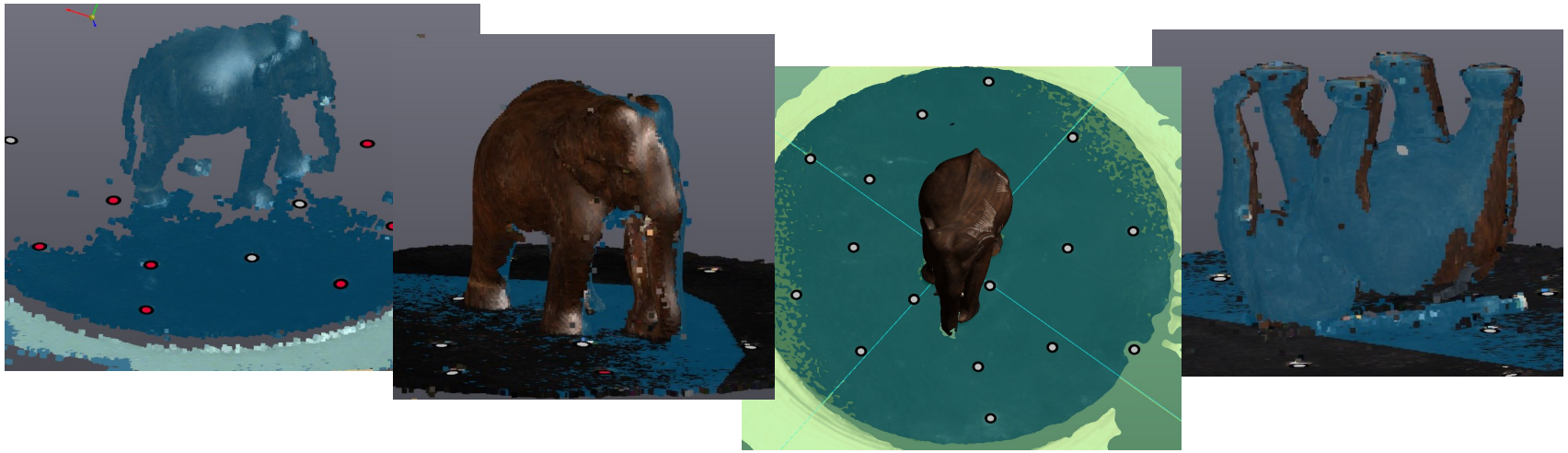


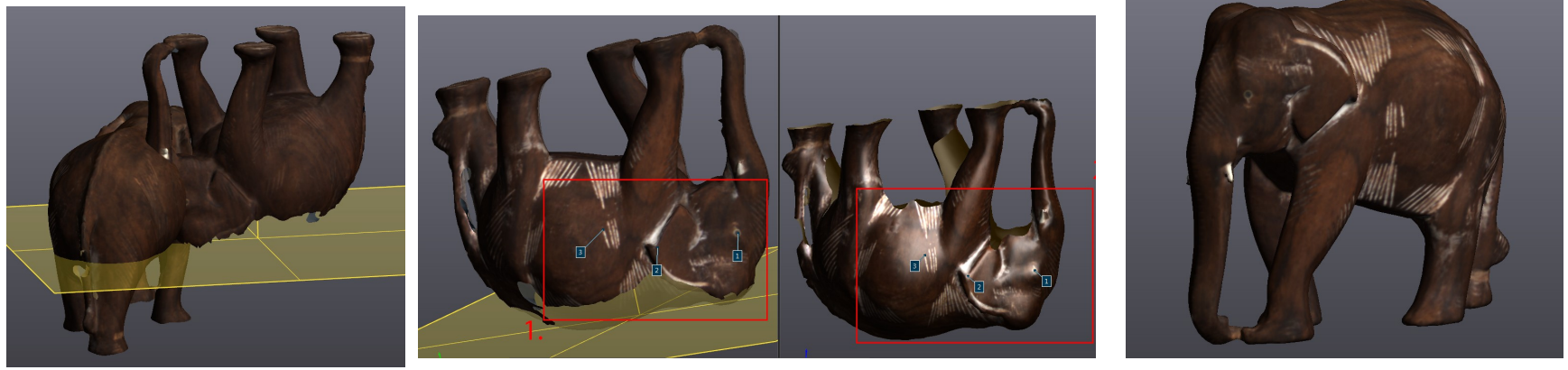


Hardware-Based 3D Scanning

Scanning

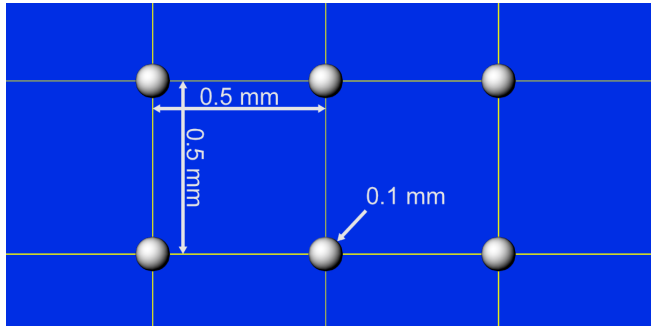
- Scan
- Merge
- (Live Demo)

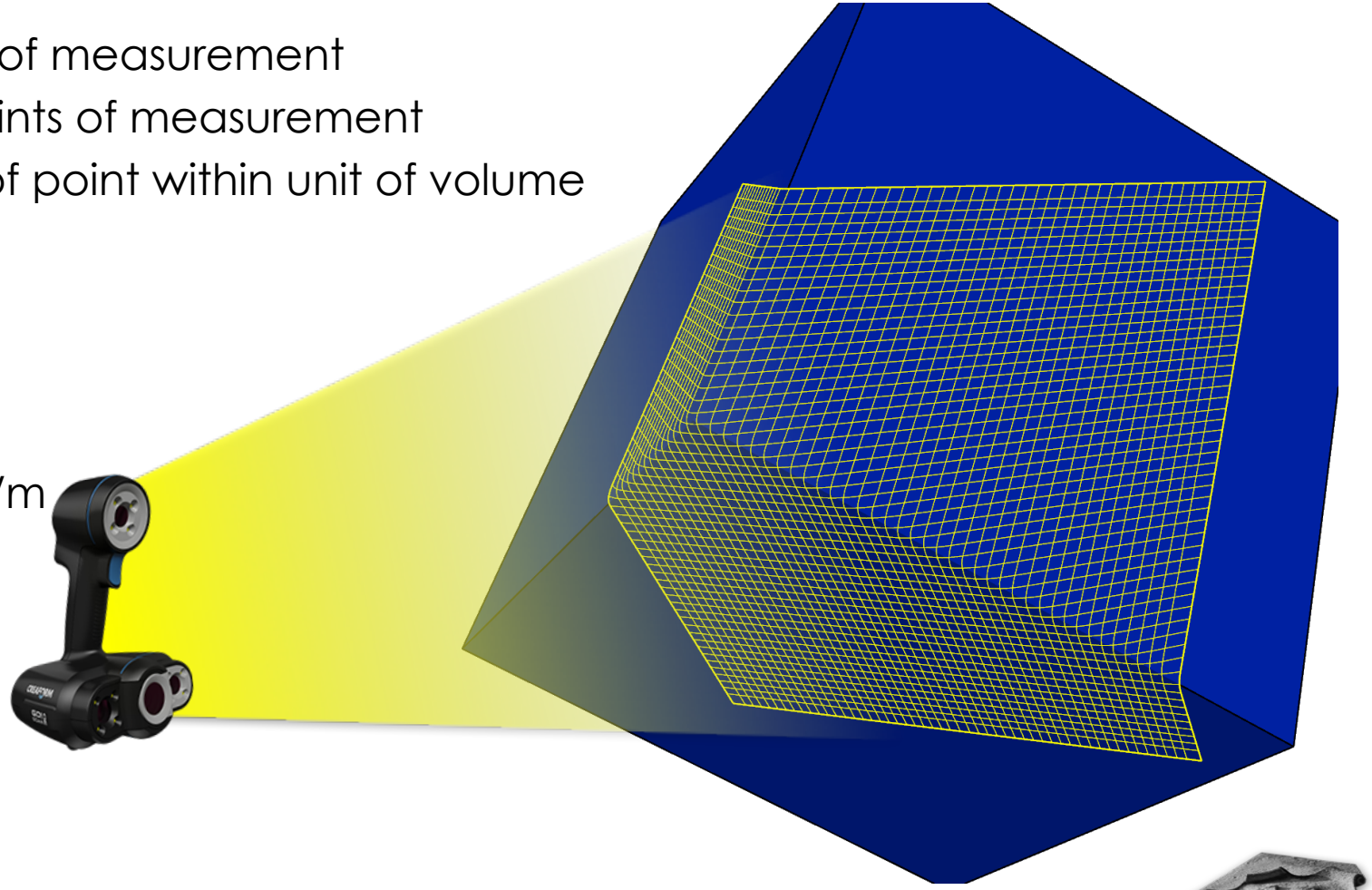




Hardware-Based 3D Scanning
Understanding the Limitations

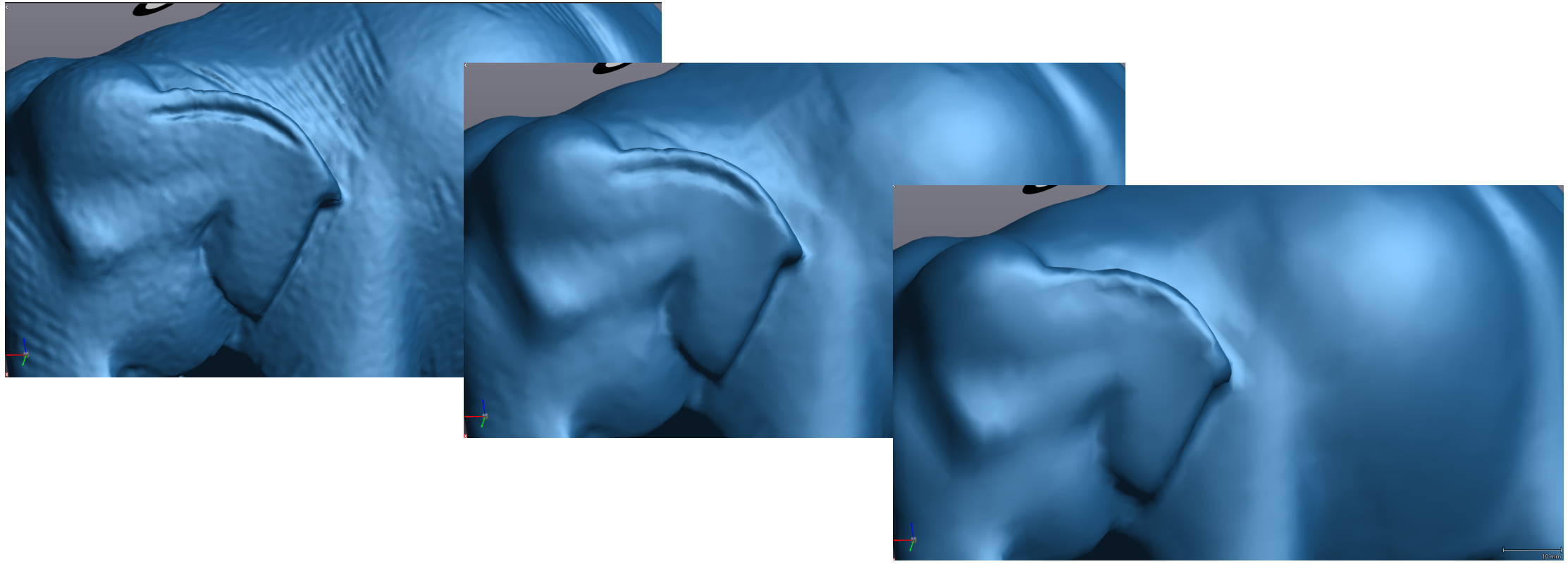
- Accuracy: Certainty at the point of measurement
- Resolution: Distance between points of measurement
- Volumetric Accuracy: Certainty of point within unit of volume
- Example:
  - Creaform GoScan 50
  - Accuracy: 0.1 mm
  - Resolution: 0.5 mm maximum
  - Volumetric accuracy: 0.3mm/m





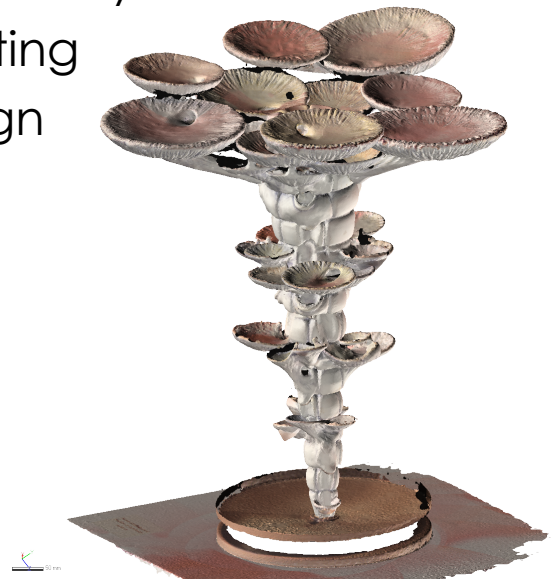
Hardware-Based 3D Scanning
Understanding the Limitations

- *Example: Elephant at 0.5, 1.0, and 2.0 mm resolution*



3D Digitization
Post-Processing

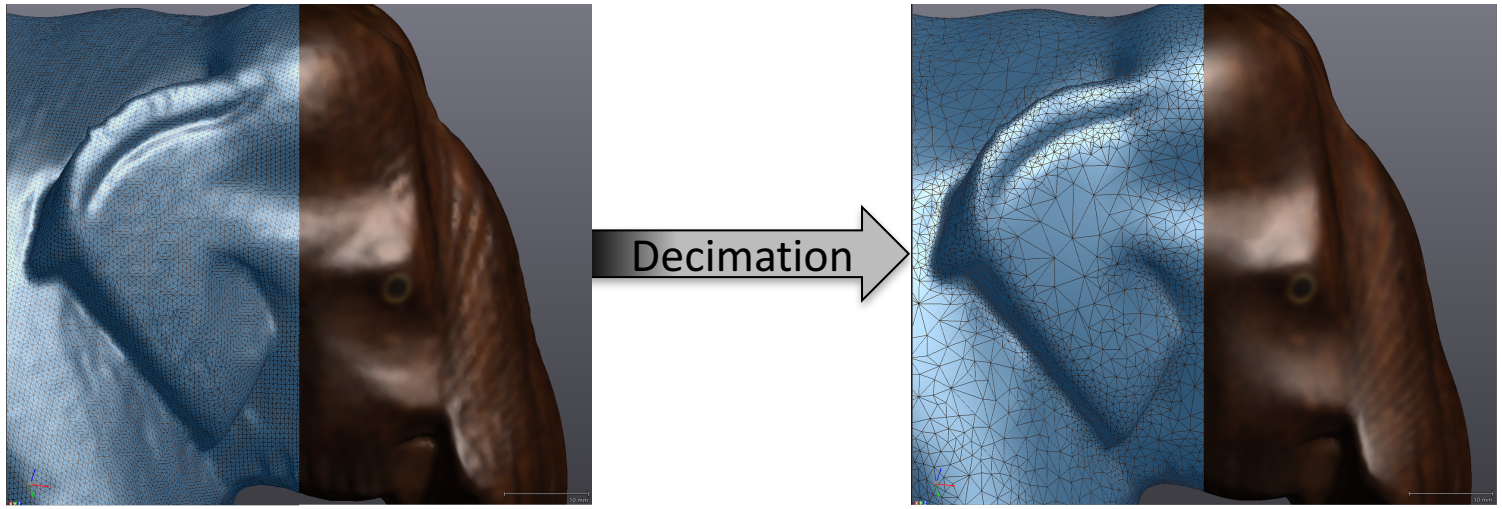
- Target applications
  - Digital preservation
  - Web delivery and interactive apps
  - 3D printing
  - Redesign



- Post-processing techniques
  - Polygon decimation
  - Polygonal hole filling
  - Color Preservation
  - Texture compression
  - Parameterization

3D Digitization
Post-Processing

- Target App: *Web Delivery*
- Post-processing techniques
  - *Polygon decimation*: Reduce the number of polygons for faster web delivery
  - *Color preservation*: Re-project source color when polygon manipulation destroys color
  - *Texture compression*: Save as JPG!



360K Polygons, ~56MB

79K Polygons, ~11MB

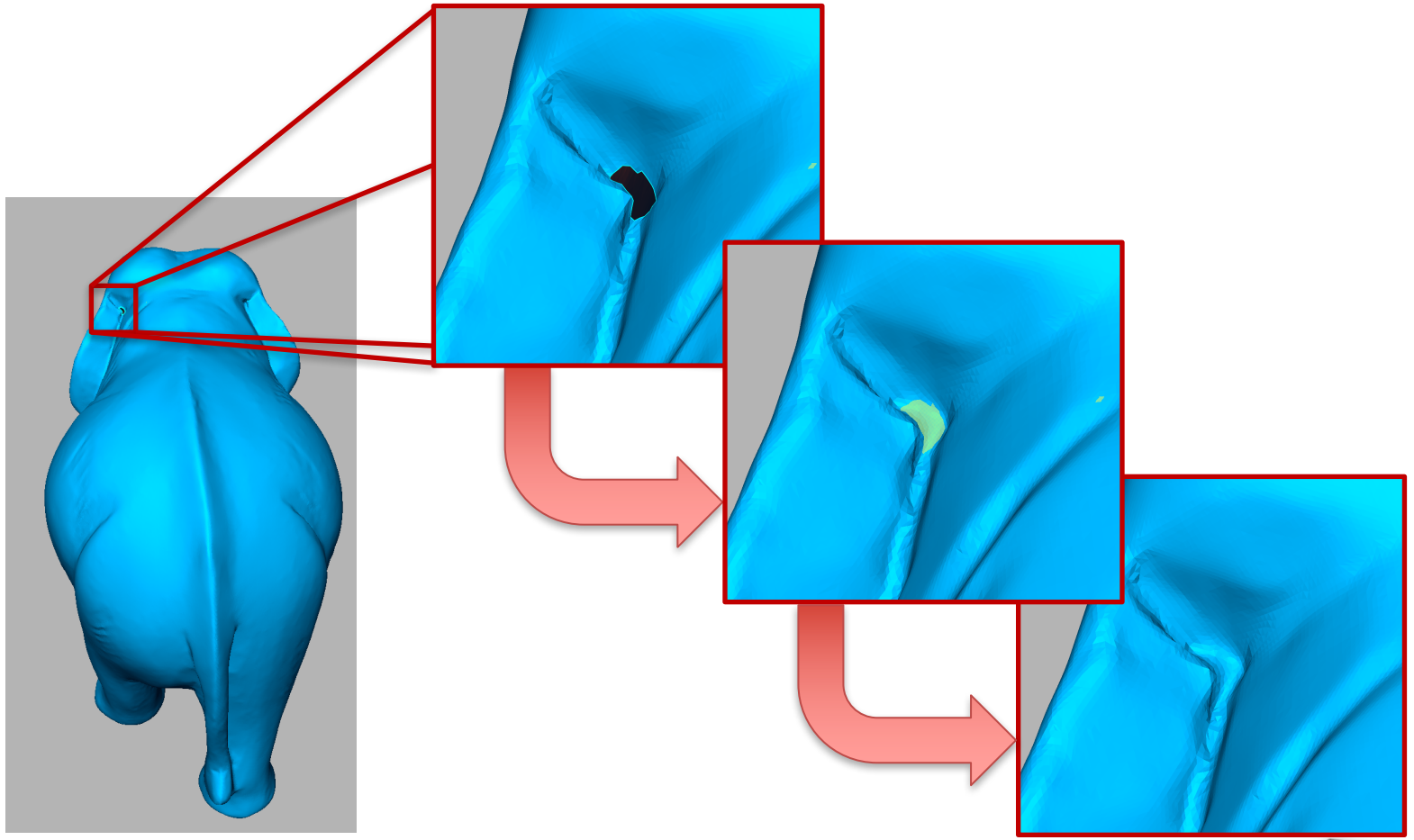
Decimated mesh

Project Source Color

Color Preserved

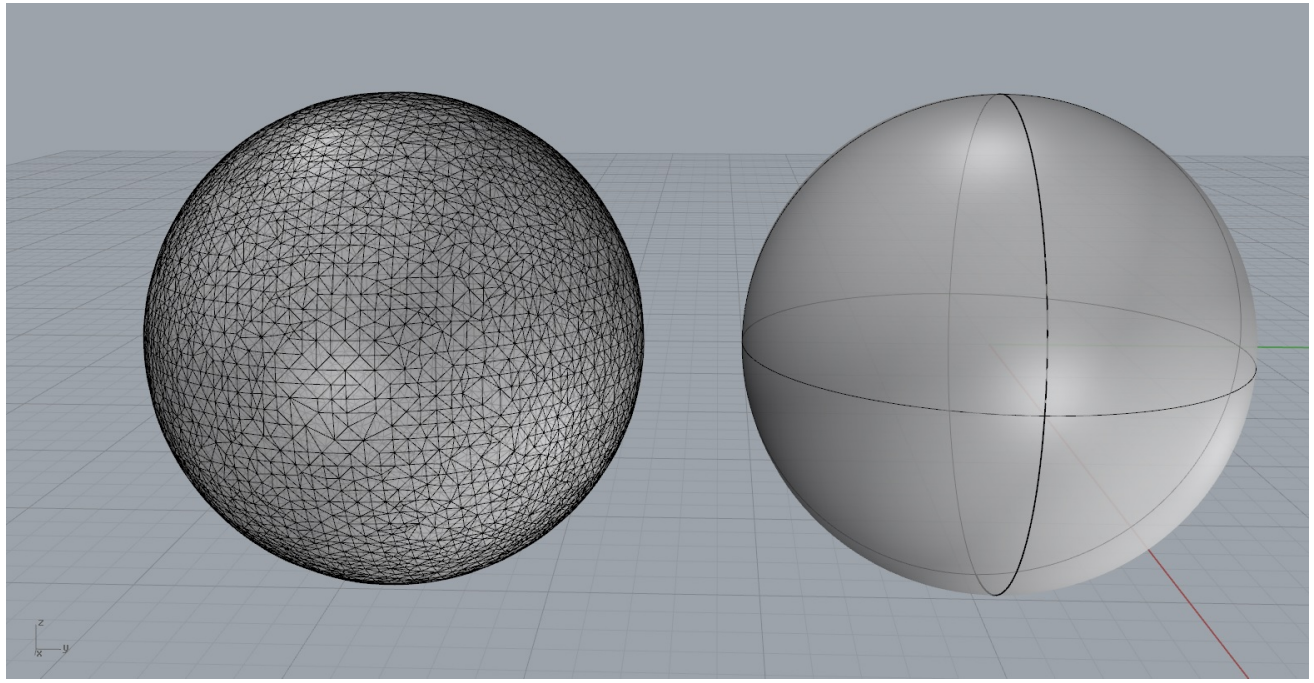
3D Digitization
Post-Processing

- Target App: *3D Printing*
- Post-processing techniques
  - *Polygonal hole filling*: Find and repair holes in the mesh including removal of cross-facing polygons resulting in watertight mesh



3D Digitization
Post-Processing

- Target App: *Redesign*
- Post-processing techniques
  - *Parameterization*: extracting the parameters that mathematically define geometric objects
    - Primitives: Spheres, Cylinders, Planes, Cubes, Cones, Pyramids, …
    - Parametric equations for curves and surfaces
- Example: *Chunkey Stone Redesign*

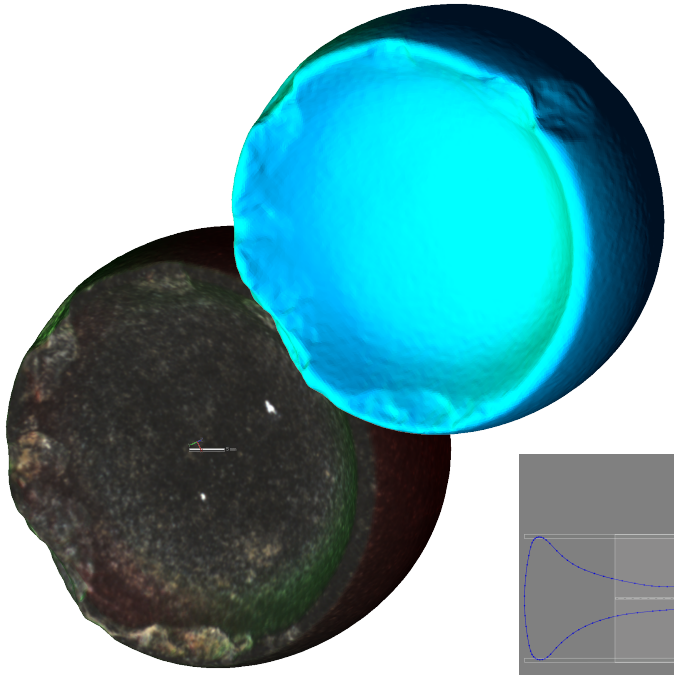


Points and Polygons

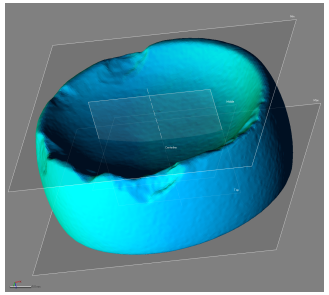
Sphere with Center and Radius

3D Digitization
Post-Processing

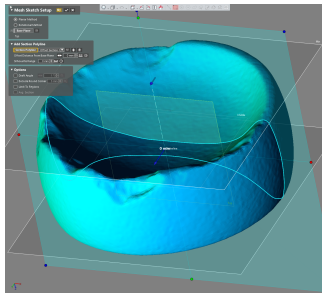
- Target Example: Chunkey Stone redesign and reproduce for cultural heritage experience



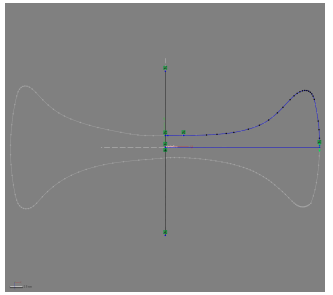
Scan Data



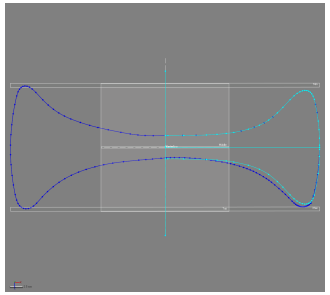
1. Extract Parameters



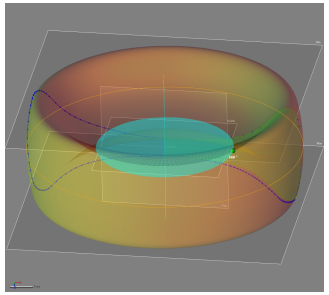
2. Cross Section



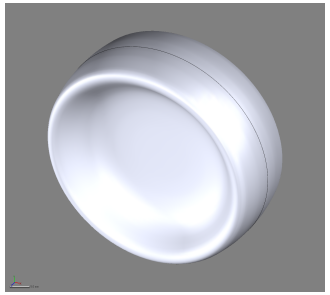
3. Sketch ¼ Section Profile



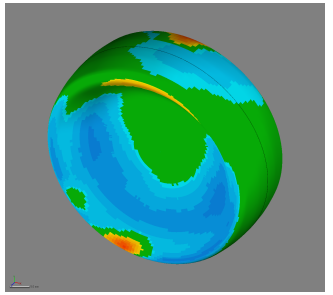
4. Mirror to ½ Profile



5. Revolve



6. Finished Part



7. Deviation Map

3D Digitization
Available IU Services

- Hardware based 3D surface scanning (AVL)
  - Small collections
    - Assess, digitize and process for you
  - Large collections
    - Train you to assess, digitize, and process
    - Support for hardware and software
    - Schedule equipment
- Photogrammetry (CyberDH)
- Volumetric scanning (IU SoM Preclinical Imaging)
- Post-processing of digitized 3D data (AVL)
  - We process or train post-processing techniques
  - Recommend existing workflows for targeted applications
  - Develop new workflows as needed

3D Digitization
Workflows

- AVL Scanning Workflows
  - VXElements
  - ZBrush
  - Geomagic Design X
  - Autodesk Meshmixer
  - 3D Slicer
  - More coming soon…

3D Digitization
Available IU Technologies

- 3D Surface scanning hardware
  - Creaform GoScan 20 for objects ~0.5" to 2'
  - Creaform GoScan 50 for objects ~6" to 10'
  - Makerbot scanners in 3D Print Labs
- Software (**Bold = Established Workflows**)
  - **Creaform VXElements** (available for IU systems)
  - **Geomagic Design X** (limited availability)
  - **Zbrush** (limited availability)
  - Autodesk Tools available to all @ IU
    - **MeshMixer,** Maya, Max, Inventor, Mudbox, …
  - Free options like Meshlab, Blender, …
  - **Slicer3D**
  - **Agisoft Photoscan on Karst** (Details: 11-10-2017)

VXelements

Geomagic

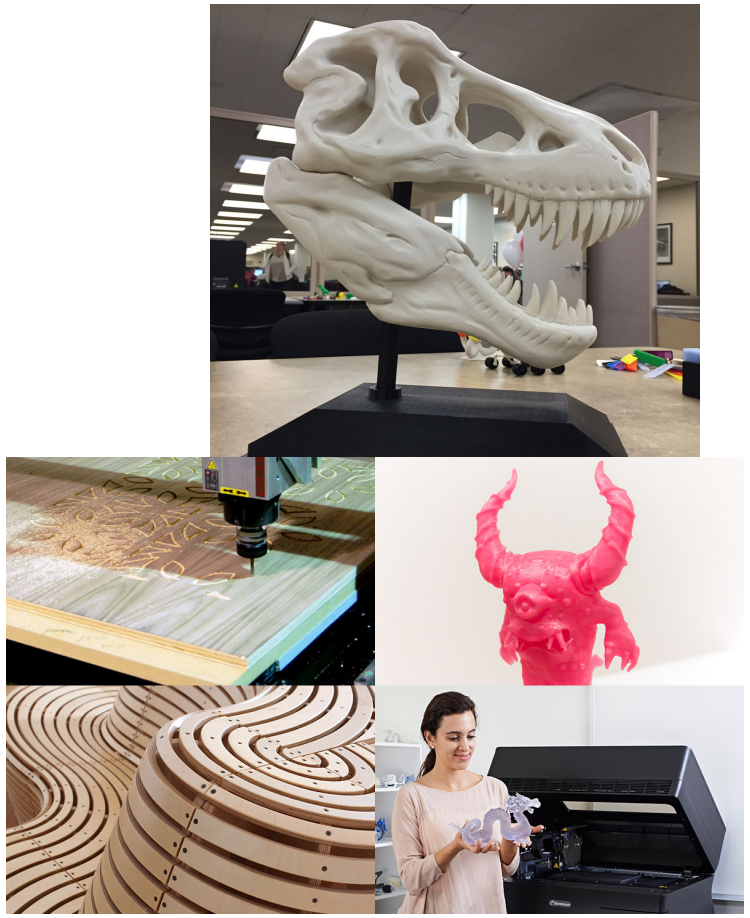
4R7

AUTODESK.

3D Printing

- IU UITS 3d Print Labs
  - MakerBots
  - Web: https://pie.iu.edu/apps/3Dprint/
  - IUB Wells Library West Tower, 4th Floor
  - IUPUI ICTC, 1st Floor
- IUB SOAAD Mad Labs
  - Web: https://soaad.indiana.edu/creative-activity/facilities/mad-labs/index.html
- IUPUI Herron Think It Make It Lab
  - Formlabs 1+, Objet30 Pro, Ultimaker
  - Web: http://www.herron.iupui.edu/think-it-make-it-lab
- IUPUI University Library 3D Printing Studio (Makerbots)
  - Web: http://www.ulib.iupui.edu/tech/3d

- Shapeways: www.shapeways.com



Thanks!

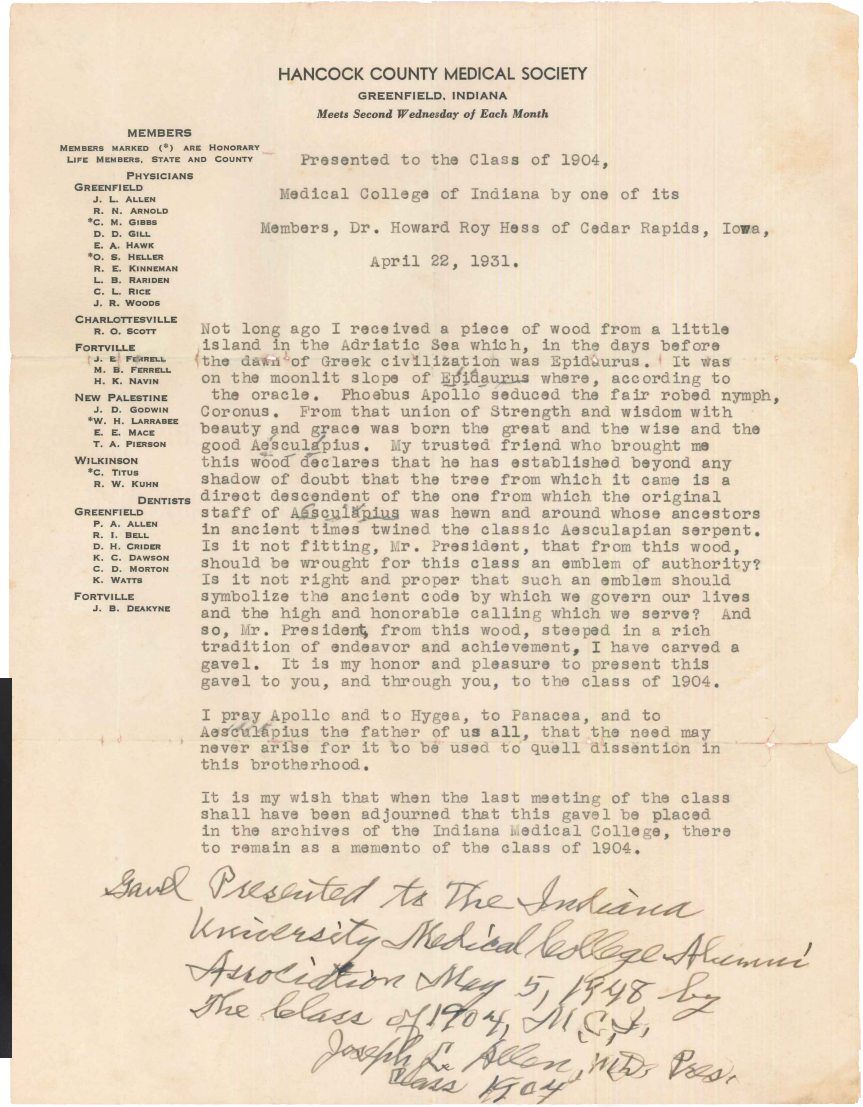
- UITS 3d Print Labs: Todd Kirk, Rob Lastinger, and Andy Webb
- IUPUI Herron Think It Make It Lab: Shelley Spicuzza
- Indiana Institute for Biomedical Imaging Sciences Preclinical Imaging: Brian McCarthy
- Ruth Lilly Medical Library: Jennifer Herron
- Center for Digital Scholarship: Jennifer Johnson and Anna Proctor
- Center for Biological Research Collections: Gary Motz
- Online Resources, Inc. : JD and Jay Schaumberg
- CyberDH: Tassie Gniady, Anna VanderJagt
- Mad Labs: Ryan Mandell
- IU East Fine Arts: Carrie Longley

Demos and Discussions

- Creaform GoScan 20 and 50 Demonstrations
  - Your Objects?
- Check out our 3D Prints

Magical Gavel

Magical?



HANCOCK COUNTY MEDICAL SOCIETY
GREENFIELD, INDIANA
Meets Second Wednesday of Each Month

MEMBERS
MEMBERS MARKED (*) ARE HONORARY
LIFE MEMBERS, STATE AND COUNTY

PHYSICIANS
GREENFIELD
J. L. ALLEN
R. N. ARNOLD
*C. M. GIBBS
D. D. GILL
E. A. HAWK
*O. S. HELLER
R. E. KINNEMAN
L. B. RARIDEN
C. L. RICE
J. R. WOODS
CHARLOTTESVILLE
R. O. SCOTT
FORTVILLE
J. E. FERRELL
M. B. FERRELL
H. K. NAVIN
NEW PALESTINE
J. D. GODWIN
*W. H. LARRABEE
E. E. MACE
T. A. PIERSON
WILKINSON
*C. TITUS
R. W. KUHN

DENTISTS
GREENFIELD
P. A. ALLEN
R. I. BELL
D. H. CRIDER
K. C. DAWSON
C. D. MORTON
K. WATTS
FORTVILLE
J. B. DEAKYNE

Presented to the Class of 1904,

Medical College of Indiana by one of its

Members, Dr. Howard Roy Hess of Cedar Rapids, Iowa,

April 22, 1931.

Not long ago I received a piece of wood from a little island in the Adriatic Sea which, in the days before the dawn of Greek civilization was Epidaurus. It was on the moonlit slope of Epidaurus where, according to the oracle. Phoebus Apollo seduced the fair robed nymph, Coronus. From that union of Strength and wisdom with beauty and grace was born the great and the wise and the good Aesculapius. My trusted friend who brought me this wood declares that he has established beyond any shadow of doubt that the tree from which it came is a direct descendent of the one from which the original staff of Aesculapius was hewn and around whose ancestors in ancient times twined the classic Aesculapian serpent. Is it not fitting, Mr. President, that from this wood, should be wrought for this class an emblem of authority? Is it not right and proper that such an emblem should symbolize the ancient code by which we govern our lives and the high and honorable calling which we serve? And so, Mr. President, from this wood, steeped in a rich tradition of endeavor and achievement, I have carved a gavel. It is my honor and pleasure to present this gavel to you, and through you, to the class of 1904.

I pray Apollo and to Hygea, to Panacea, and to Aesculapius the father of us all, that the need may never arise for it to be used to quell dissention in this brotherhood.

It is my wish that when the last meeting of the class shall have been adjourned that this gavel be placed in the archives of the Indiana Medical College, there to remain as a memento of the class of 1904.

Gavel Presented to The Indiana University Medical College Alumni Association May 5, 1948 by The Class of 1904, M.C.I.,
Joseph L. Allen, M.D. Pres.
Class 1904